Maintaining Adult Bivalves for long Periods on Artificially Grown Phytoplankton

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KEEPING BIVALVES ALIVE in a laboratory by addition of artificially cultivated phytoplankton to sea water is not new and was practiced at U. S. Fisheries Laboratory at Milford, Connecticut, for a number of years (LOOSANOFF & ENGLE, 1947; LOOSANOFF & DAVIS, 1963). In those cases, however, the water passing through the laboratory contained natural plankton and, of more importance, maintenance of animals under such conditions was of relatively short duration, rarely exceeding 2 or 3 months. Because of the circumstances described herein this report discusses observations made under rather radically different conditions.

In October of 1971 two groups of mussels, *Perna canaliculus* (Gmelin, 1791), were shipped from New Zealand to the Pacific Marine Station located near the entrance to Tomales Bay on the central coast of California. One of the groups was collected near Auckland, North Island, and the other was shipped from Marlborough Sound, South Island. The mussels were imported for studies of their physiological and ecological requirements. They were introduced into California with the knowledge of the New Zealand fishery authorities and permission of the State of California Department of Fish and Game.

Upon arrival the mussels were placed in running sea water which, after passing through water tables containing the mollusks, is discharged into a special dry well located more than 1800 feet (540m) from the seashore. Thus, to avoid the introduction of undesirable exotic organisms into California waters the mussels have been kept in strict quarantine.

As is well known, mussels are filter-feeding animals, existing principally on marine phytoplankton. However, the peculiarity of the sea water system at the Pacific Marine Station is such that before entering the storage tanks it is drawn through a layer of sand and therefore becomes virtually devoid of natural plankton. Since the mussels would starve under such conditions, a method had to be employed for introducing relatively large quantities of phytoplankton into the water. The problem was solved on the basis of our previous experience in growing phytoplankton on a massive scale by enriching stored sea water with commercial fertilizers (LOOSANOFF & ENGLE, 1942; LOOSANOFF, 1951). Briefly, in the present experiment we use 2 redwood tanks, 8 feet (2.4 m) in diameter, and approximately 24 inches (60 cm) deep, which are filled with sea water to a depth of about 18 inches (45 cm), and then enriched with tobacco fertilizers designated by the formula 6 - 3 - 6 at the rate of 0.5 gr per liter. This fertilizer is used by tobacco growers in Connecticut. Other fertilizers containing no insecticides and weedicides were also quite efficient. The tanks are aerated continuously to maintain the plankton in suspension and to expose the individual cells to the effect of light. During winter the cultures are illuminated and warmed by incandescent lamps kept burning continuously over the tanks.

The mass cultures were inoculated with several species of algae, but *Phaeodactylum tricornutum* (Bohlin) was normally predominant, although *Dunaliella tertiolecta* (Butcher) was also of common occurrence, though in much smaller numbers. The cultures were started about 2 weeks apart to prevent their becoming too old, because it was found in the past that such cultures may be toxic to bivalves (LOOSANOFF & ENGLE, 1947; LOOSANOFF & DAVIS, 1963). Usually the cultures became quite dense within a week after the inoculation, the color being light brown because of the preponderance of *P. tricornutum*.

The plankton culture was fed into the troughs containing the mussels and mixed at the entrance with the running sea water. The mussels readily digested the plankton

cells and formed normal feces. In cases when too much food was introduced, excessive quantities of pseudofeces were formed, but as soon as the situation was corrected normal feeding behavior resumed.

Except for several cases of initial mortality caused by the stress experienced during shipment, the mussels suffered virtually no losses for a period of about 9 months. During this time many individuals in both groups showed new shell growth, and natural, apparently normal, spawning occurred on at least two occasions. Towards the end of the year, however, several large mussels of the northern group died, but at the time this report is being written the majority of the mussels of the southern group and approximately 75% of the northern mussels are still living after being artificially fed for more than 17 months.

We are not aware of the exact cause of the mortality of the mussels, but it is possible that since our plankton cultures consisted, as a rule, of only one or two species of diatoms, the diet may have been deficient in some respects. This situation is easily correctable by growing more diversified mass cultures. Another probable cause of the mortality was stress due to several failures in the sea water system at which time the mussels received only recirculated sea water. In one instance when the mussels were kept under this condition for 8 days, mortality sharply increased.

Thus, even with limited facilities, it has been demonstrated that bivalves may be successfully kept alive for a period of about a year and a half while being fed exclusively artificially grown phytoplankton. These observations clearly illustrate once more the possibility for maintaining and raising, possibly far from the ocean, such mollusks as mussels, oysters, and clams, as well as other filter-feeding organisms, for at least 17 months in sea water lacking natural food. They also suggest many practical uses in mariculture, especially in shellfish farming.

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